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| ForexClear  Initial Margin Model: FxPAR  (FX Spots, Forwards and Options)  Methodology Document |

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# Introduction

This document is a technical information specification for LCH.Clearnet Ltd’s ForexClear Initial Margin model, ***FxPAR*** *(****“Foreign Exchange Portfolio Analysis and Risk”****)*. This document provides full details of the *FxPAR* methodology, specifically focused on FX Spot, Forward, and Option contracts.

ForexClear currently clears OTC foreign exchange non-deliverable forward (“NDF”) contracts. The FxPAR methodology currently applies to NDF contracts and will be extended to incorporate deliverable FX Spots, Forwards and Options. However, portfolio margining between Emerging Market NDF contracts and G10 FX Spots, Forwards, and Options will not be permitted initially, although this extension may be considered at a later stage.

ForexClear currently supports both Dealer-to-Dealer and Client Clearing for the NDF contracts. For the initial launch of non-deliverable FX Spots, Forwards, and Options clearing, only a Dealer-to-Dealer service will be offered.

Initial Margin (“IM”) is calculated and collected in USD from each ForexClear member to cover the potential losses arising from that member’s default over a specified close-out period under normal market conditions.

ForexClear IM is calculated using an Expected Shortfall (“ES”) model reflecting a minimum confidence level of 99.7% consistent with LCH.Clearnet Board risk appetite, based on a holding period of five days for house accounts (seven days for client accounts where relevant).

# Product Scope

In addition to its existing NDF clearing service, ForexClear will clear FX Spots, Forwards and FX Options OTC contracts for the following currency pairs:

* AUD/USD (Australian Dollar vs US Dollar)
* EUR/CHF (Euro vs Swiss Franc)
* EUR/GBP (Euro vs British Pound)
* EUR/JPY (Euro vs Japanese Yen)
* EUR/USD (Euro vs US Dollar)
* GBP/USD (British Pound vs US Dollar)
* USD/CHF (US Dollar vs Swiss Franc)
* USD/JPY (US Dollar vs Japanese Yen).

The tables below outline the product scope for the cleared contracts.

Table 1 - Eligibility Criteria for FX Options

|  |  |
| --- | --- |
| **Category** | **Definition** |
| **Product** | LCH Deliverable FX Options |
| **Option Style** | European Vanilla |
| **Underlying Asset** | Eligible LCH Spot (*Forward TBD*) |
| **Expiry Range** | Minimum: 1 business day  Maximum: 2 years |
| **Cut Times** | New York: 10:00 (local time)  Tokyo: 15:00 (local time) |

Table 2 - Eligibility Criteria for FX Spots/Forwards

|  |  |
| --- | --- |
| **Category** | **Definition** |
| **Product** | LCH Spot or Forward |
| **Tenor Range** | Minimum: Spot  Maximum: 2 years |
| **Settlement** | Physical delivery via CLS |

Table 3 - FX Options and Spot/Forward Product Conventions

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Category** | **EUR**  **/USD** | **EUR**  **/CHF** | **EUR**  **/GBP** | **EUR**  **/JPY** | **GBP**  **/USD** | **AUD**  **/USD** | **USD**  **/CHF** | **USD**  **/JPY** |
| **Base currency** | EUR | EUR | EUR | EUR | GBP | AUD | USD | USD |
| **Term currency** | USD | CHF | GBP | JPY | USD | USD | CHF | JPY |
| **Quote basis** | Term per Base | | | | | | | |
| **Pip size** | 0.0001 | 0.0001 | 0.0001 | 0.01 | 0.0001 | 0.0001 | 0.0001 | 0.01 |
| **Spot** | T+2 | T+2 | T+2 | T+2 | T+2 | T+2 | T+2 | T+2 |
| **Bus day calendars** | TE, FD | TE, SZ | TE, GB | TE, JN | GB, FD | AU, FD | FD, SZ | FD, JN |
| **Prem-included delta** | No | Yes | Yes | Yes | No | No | Yes | Yes |
| **Option premium ccy** | Base or Term currency | | | | | | | |
| **Option premium date** | Spot or Forward | | | | | | | |
| **ATM vol convention** | *Expiry less than 10 years*: Delta-neutral straddle | | | | | | | |
| **Delta convention** | *Expiry less than 2 years*: Spot delta  *Expiry 2 years or more*: Forward delta | | | | | | | |

# Methodology Description

## Overview

ForexClear IM is calculated using the *FxPAR* methodology which is a historical simulation conditional value-at-risk (CVaR) model with volatility scaling. The *FxPAR* model uses approximately ten years (2500 scenarios) of historical market price/vol changes to simulate potential changes in portfolio value. A margin period of risk (ie. holding period) of five days is used for house accounts (seven days for client accounts where relevant). An estimate of potential loss is calculated from the distribution of simulated portfolio value changes using an ES tail measure based on the average of the 7 worst case losses, reflecting a minimum confidence level of 99.7% consistent with LCH.Clearnet Board risk appetite.

*FxPAR* addresses the effects of volatility clustering in FX spot and interest rate markets by implementing a volatility scaling methodology[[1]](#footnote-1), whereby historical return scenarios are explicitly scaled to reflect divergences between historical and prevailing market conditions.

The *FxPAR* model calculates portfolio IM as follows:

* 1. **Risk Factor Time Series Data:** Obtain times series data for each relevant risk factor consisting of 2505 days of historical observations.
  2. **Unscaled Returns:** For each risk factor time series, calculate 2500 historical return scenarios based on overlapping five-day returns.
  3. **Forward Volatilities:** For spot rate (USD currency pairs only) and interest rate time series, estimate five-day forward volatility as at each scenario date using an Exponentially Weighted Moving Average (EWMA) model.
  4. **Scaled Returns:** For spot rate (USD currency pairs only) and interest rate time series, calculate 2500 scaled return scenarios by (i) dividing *Unscaled Returns* by the relevant historical volatility as at the scenario date, and (ii) multiplying (i) by the average of current volatility and historical volatility as at the relevant scenario date.
  5. **Simulated Risk Factors:** For each risk factor time series except the spot rate of non-USD currency pairs, calculate 2500 simulation scenarios using *Scaled Returns* applied against current market rates. For non-USD currency pairs, triangulate the scenario spot rates using USD currency pairs.
  6. **Simulated Portfolio Valuations:** Revalue the portfolio (in reporting currency) under each of the 2500 simulated risk factor scenarios.
  7. **Simulated P&L:** Calculate portfolio profit and loss (in reporting currency) under each of the 2500 simulated scenarios by subtracting the total current MTM valuation from the *Simulated Portfolio Valuation* calculated in step 6.
  8. **IM Estimation:** Based on the distribution of 2500 simulated P&L scenarios, the Initial Margin is calculated as the average of the largest 7 worst case losses.

## Margin Period of Risk (Holding Period)

ForexClear’s assumed holding period of five days for House accounts is based on the expected time required to hedge and auction a member's portfolio in the event of ForexClear member default.  The holding period is based on input from market participants and the ForexClear Default Management Group (“FXDMG”) given an assessment of typical traded volumes, available market liquidity, and consideration of the overall default management process, as well as LCH.Clearnet’s extensive experience of managing member defaults in OTC markets.

LCH.Clearnet conducts regular default management fire-drills together with the FXDMG to ensure that actual portfolios held can be adequately hedged and auctioned within the assumed holding period.

Notwithstanding the assumed holding period, ForexClear also monitors risk exposures that may require more time to hedge/liquidate or that would incur greater cost to fully unwind within the assume time.  ForexClear’s Liquidity Risk Margin add-on forms an additional component of a member’s margin liability and is based on the potential cost of unwinding sizeable positions in excess of standard clip sizes[[2]](#footnote-2). Liquidity Risk Margin multipliers are reviewed by LCH.Clearnet and the FXDMG on a quarterly basis.

## Confidence Level

ForexClear IM is calculated using an Expected Shortfall (“ES”) tail measure based on the average of the seven worst case losses, reflecting a minimum confidence level of 99.7%.

ForexClear’s target confidence level is consistent with LCH.Clearnet Board risk appetite which stipulates that initial margin should cover close-out losses in all but extreme market conditions. Extreme market conditions are quantified by LCH.Clearnet’s Board Risk Appetite statement as conditions which occur outside of a 99.7% confidence level.

Potential losses which occur outside of a 99.7% confidence level are monitored through stress testing and covered by the ForexClear Default Fund[[3]](#footnote-3).

## Model Coherence

We can define what is known as a spectral risk measure by making observations about the weights assigned to quantiles of the loss distribution.

A general result is that a spectral risk measure is coherent if the weight assigned to the *X*-th quantile of the loss distribution is a non-decreasing function of *X*.

The ES tail measure satisfies the above condition since it gives equal weight to all quantiles greater than the *X*-th quantile and zero weight to all quantiles below the *X*-th quantile., whilst a fixed quantile VaR measure does not because the weights assigned to quantiles greater than *X* are less than the weight assigned to the *X*-th quantile.

More generally, a financial risk measure is defined as coherent if it possesses the following properties:

* **Monotonicity** – if a portfolio has lower returns than another portfolio for every state of the world, its risk measure should be greater.
* **Translation invariance** – if we add an amount of cash C to a portfolio, its risk measure should go down by C.
* **Homogeneity** – changing the portfolio size by a factor Y while keeping the relative amounts of different items in the portfolio the same should result in the risk measure being multiplied by Y.
* **Sub-additivity** – the risk measure for two portfolios after they have been merged should be no greater than the sum of their risk measures before they were merged.

ES satisfies all four of the properties that a coherent risk measure should have.

## Volatility Scaling

Hull and White (1998) show that the probability distribution of a market variable, when scaled by an estimate of its volatility, is often found to be approximately stationary. Stationarity implies that the probability of occurrence of a specified loss is the same for each day.

From a theoretical perspective, the historical simulation used by *FxPAR* relaxes the assumption of stationarity in that historical returns are first standardised by volatility estimated on that particular day. As such, this normalisation process yields approximately independent and identically distributed (i.i.d) returns desirable for historical simulation. Before normalised returns are used as innovations they are scaled (ie. multiplied) by an appropriate value, eg. the current conditional forecast of volatility to reflect current market conditions (Hull-White model), or by a long-term quantile of historical volatility to provide more stable, and generally conservative, outcomes (as adopted for the Margin Floor Estimate).

Barone-Adesi and Giannopoulos (2000) further note that when returns are i.i.d. and the moments of the distribution are known, any inference made about potential portfolio losses will be accurate and unchanging over time.

The scenario scaling scheme used in the *FxPAR* model explicitly addresses the issue of volatility clustering frequently observed in historical financial returns. The shifts in each scenario are scaled to reflect variations between historical conditional volatility and the prevailing market environment using the forward volatilities estimated above.

A major advantage of *FxPAR* over standard historical simulation is that the volatility scaling process increases the range of outcomes beyond the historical record through a change of scale. In other words, the method used by *FxPAR* provides a systematic approach to generate extreme events not present in the historical record, completing the tails of the distribution.

## Calculation Frequency

ForexClear IM covering FX Spot, Forward and Option contracts is calculated using a full portfolio revaluation at multiple Risk Runs throughout the day and also at point of trade/package submission.

## Assumptions and Limitations

The *FxPAR* methodology makes the following key assumptions:

* A five day holding period is sufficient to hedge or liquidate the defaulting member’s portfolio.
* The empirical distribution of historical returns of each individual risk factor reflects a reasonable and likely distribution of potential outcomes over the holding period.
* A EWMA decay factor of 0.97 provides the most appropriate speed of adjustment to changes in market volatility used in the historical simulation algorithm.[[4]](#footnote-4)
* The volatility scaling scheme sufficiently allows for the relaxation of the assumption of multivariate normality in the historical data.

The *FxPAR* model, as with all value-at-risk models, has the following limitations:

* The model does not indicate the maximum a portfolio can lose; it only measures the maximum expected loss under current market conditions. However, use of an ES tail measure offers benefit in providing a conditional measure of expected loss.
* The model provides a statistical estimate of probable loss under normal market conditions and is not designed to cope with abnormal or extreme price changes. LCH.Clearnet implements stress testing of member portfolio’s to assess supplementary risk under extreme but plausible market conditions.
* The model is purely a market risk measure and does not quantify other risk exposures, including liquidity risk, credit risk, or country risk. LCH.Clearnet calculates these supplementary risk exposures in the form of separate and additional margin components.

# Valuation Model

The *FxPAR* valuation model for eligible contracts is based on industry standard pricing methodology using Murex’s standard ‘FX Forward Model’ and ‘FX Option Model’.

For the purposes of ForexClear valuation, each trade is valued in a specific VM currency using current market interest and discount rates; for the purposes of margining in a single liability reporting currency, each trade P&L is converted to Reporting Currency (ie. USD) using historically simulated FX spot rates.

## VM / Reporting Currency Conventions

As the standard valuation models are defined to calculate value of an FX trade in terms of term currency, we will need to convert this term currency first into a VM Currency and, where required, into a Reporting Currency so that all liabilities can be aggregated.

The VM / Reporting currency for each currency pair is as follows

Table 4 – VM / Reporting Currency Conventions

|  |  |  |
| --- | --- | --- |
| **Currency Pair** | **VM Currency** | **Reporting Currency** |
| **AUD/USD** | USD | USD |
| **EUR/CHF** | EUR | USD |
| **EUR/GBP** | EUR | USD |
| **EUR/JPY** | EUR | USD |
| **EUR/USD** | USD | USD |
| **GBP/USD** | USD | USD |
| **USD/CHF** | USD | USD |
| **USD/JPY** | USD | USD |

## Methodology

Depending on the type of contract, each position *i* is valued as follows:

### FX Forwards: (1)

and

(2)

### FX Options:  (3)

and

(4)

(5)

The variables in equations (1)-(5) are defined as:

= simulated value of position *i* in VM currency

= notional of position *i* in base currency

= FX forward rate between spot date and trade settlement date expressed as term per one unit of base currency

= FX spot rate expressed as term per one unit of base currency

= FX spot Rate (VM currency per term currency)

= FX trade rate expressed as term per one unit of base currency

= Time (in years) from regular spot date to trade expiry date

= 1 for calls, -1 for puts

= FX implied volatility (based on interpolation of the underlying scenario’s volatility surface. Linear interpolation used in time-space and log moneyness-space)

= natural logarithm

= Cumulative Normal Distribution function

= base currency zero coupon swap rate between spot date and trade settlement date (based on linear interpolation of continuously compounded zero rates where required)

= term currency zero coupon swap rate between spot date and trade settlement date (based on linear interpolation of continuously compounded zero rates where required)

= discounting zero coupon rate (dictated by the VM currency) between valuation date and trade settlement date (based on linear interpolation of continuously compounded zero rates where required)

= accrual factor based on appropriate day count convention between dates *a* and *b*

= valuation date

= regular spot date

= trade settlement date

## VM / Reporting Currency Conversion

In order to capture FX risk in the conversion from VM Currency to Reporting Currency, the calculation will use the simulated scenario spot rate, ie:

where,

= simulated value of position *i* at time *t* in Reporting Currency.

= simulated value of position *i* at time *t* in VM Currency.

= simulated FX spot rate (Reporting Currency per VM Currency) at time *t.*

# Initial Margin Calculation Details

## Risk Factors

For valuation and margining purposes, FX Spot and Forward contracts are exposed to the following risk factors:

* FX spot rates;
* FX zero coupon swap rates (implied from FX forward rates)
* FX zero coupon overnight interest rates

FX Option contracts are exposed to the above risk factors as well as:

* FX implied volatilities

All the above risk factors are included in the *FxPAR* model for the purposes of calculating portfolio value-at-risk.

For each risk factor, a time series consisting of the most recent 2505 historical price observations is used as an input into the *FxPAR* model.

## Unscaled Returns

The *FxPAR* model calculates returns on FX rates and implied vols in relative terms and on interest rates in absolute terms, as follows:

(6)

where,

= return calculated at time *t*

= price (or rate, yield etc) at time *t*

= holding period assumed (ie. five days for ForexClear)

## Forward Volatilities

For FX spot rates and interest rates, the *FxPAR* model uses an Exponentially Weighted Moving Average (EWMA) model to estimate forward volatility, as follows:

(7)

where,

= volatility at time *t*

= unscaled return at time *t*

= EWMA decay factor (ie. 0.97 for ForexClear)

In order to initiate the calculation of the volatility series using the EWMA method, a seed volatility is required for each series. Each seed volatility is calculated based on the sample standard deviation of *n* observations prior to the last scenario date, as follows:

(8)

where,

= seed volatility

= unscaled return at time

= mean unscaled return over the *n* days prior to the last scenario date

= first business day prior to the last scenario date

= number of observations (ie. 60 days)

## Scaled Returns

The *FxPAR* model calculates scaled returns for both FX spot rates and interest rates (not implied vols) by weighting each unscaled scenario return, , as follows:

(9)

where,

= scaled return at time *t*

= unscaled return at time *t*

= volatility at time *t*

= volatility at valuation date

= historical volatility weighting (ie 0.5 for ForexClear)

## Simulated Risk Factors

The *FxPAR* model calculates simulated risk factors based on the underlying method used for calculating the unscaled scenario returns, as follows:

(10)

where,

= simulated price (or rate, yield, implied vol etc) at time *t*

= market price (or rate, yield, implied vol etc) at valuation date

= scaled return at time *t*

= unscaled return at time *t*

## Simulated Portfolio Valuations

For each portfolio, the simulated portfolio value is computed by position and aggregated at portfolio level, ie. the portfolio value is the sum of the value of its positions. Each position is the aggregation of trades sharing the following common characteristics:

* Member account;
* Trade type;
* Instrument;
* Maturity; and
* Buy/Sell indicator.

For each scenario, the simulated portfolio value is the sum of all position values in the portfolio, as follows:

(11)

where,

= simulated value of the portfolio at scenario date *t* in Reporting Currency

= simulated value of position *i* at scenario date *t* in Reporting Currency

= number of positions in the portfolio

To account for passage of time during the holding period, FxPAR simulates a new valuation day, five business days after the actual valuation date when valuing the portfolio for simulated scenarios. For trades in which the simulated valuation date is past the trade expiry or settlement date, we take the intrinsic value of the trade.

## Simulated Profit and Loss

The simulated portfolio P&L for each scenario is computed by subtracting the total current portfolio value from the simulated portfolio value (both converted to reporting currency using scenario spot rate), as follows:

(12)

where,

= simulated portfolio P&L in reporting currency at time *t*

= simulated value of the portfolio at scenario date *t* in reporting currency

= current value of the portfolio in reporting currency

## Initial Margin Estimation

Based on the distribution of 2500 simulated P&L scenarios produced for a given member’s portfolio, the core FxPAR Initial Margin estimate is calculated as the average of the eight largest portfolio losses.

## IM Floor Estimation

In addition to the calculations of the core IM detailed above, an IM Floor is separately calculated. The IM Floor estimation is carried out in steps similar to the margin calculation above, with the exception of the scaled returns, which are calculated in the manner described below:

The IM Floor model scaled returns are calculated by weighting each unscaled scenario return, , as follows:

(13)

where,

= scaled return at time *t*

= unscaled return at time *t*

= 75th percentile of volatilities from the 2500 scenarios previous to *t*

Note: as with the core FxPAR IM methodology, the scaling used in the IM Floor estimation is only applied to the spot rate and interest rate risk factors.

## Maximum Loss Comparison

After both the FxPAR IM Estimate and the IM Floor Estimate have been calculated, the maximum loss estimate of the two is taken as the resultant margin value.

# Volatility Surface

## Construction

Implied volatility surface market data is provided in the form of ATM implied volatility, Risk-Reversal (“RR”) and Butterfly (“FLY”) quotes which are used in the construction of a volatility surface for each currency pair. The corresponding implied volatility surfaces for each currency pair are explicitly deduced from RR and FLY quotes received.

Implied volatility surfaces are defined on a point-wise basis by delta *d* (10C,25C,ATM,25P,10P) and tenor *T* (O/N,1W,2W,1M,2M,3M,6M,9M,1Y,18M,2Y) using the following formulas for RR and FLY quotes (commonly referred to as ‘Broker Risky’ and ‘Broker Fly’ quote conventions):

(14)

(15)

## Interpolation and Extrapolation

For a given scenario, to find the corresponding implied volatility parameter *σ* used in the FX Option valuation methodology, interpolation is performed along the implied volatility surface on both the delta and tenor axes. First interpolation is applied on the moneyness axis of the two neighbouring implied volatility smiles and then tenor axis interpolation is applied to these two points.

### Delta axis interpolation

Deltas are converted into log-moneyness and then a constrained cubic spline interpolation[[5]](#footnote-5) in log-moneyness space is applied. Each volatility smile has flat extrapolation before/after the first/last point.

### Tenor axis interpolation

All implied volatility quotes are annualised measures, and as such need to be scaled by a function of time to expiry. FxPAR assigns a weighting to each day from spot date to 2Y tenor to adjust for lower volatility over the weekend. At service launch, we assign a weighting of 100% to each week day and a weighting of 10% to each non-business day, ie weekend days.

Linear interpolation is then applied in variance space using the volatility day weighting scheme. Flat extrapolation is used before/after the first/last tenor (in the unlikely event that this is required). To interpolate for a given time between tenors with time to expiries and , the following is applied:

(16)

where,

= Implied volatility at tenor *n*

= Implied volatility at tenor *n-1*

= Number of business days between tenors *n-1* and *n*

= Number of business days between tenor *n-1* and day to interpolate on

= Number of non-business days between tenors *n-1* and *n*

= Number of non-business days between tenor *n-1* and day to interpolate on

= Weighting applied to non-business days.

## De-Arbitraging

To prevent arbitrages on the input volatility surfaces impacting the *FxPAR* IM calculation, a de-arbitraging methodology will be applied where an arbitrage exists on any reference volatility surfaces.

A volatility surface is identified as having an arbitrage when one of the following conditions are not met for all tenor points and delta points along the surface:

1. **Call Spread Condition** – A call with lower strike should be worth more than a call of higher strike having the same maturity. This check can be represented as follows:

(17)

1. **Calendar Spread Condition** – A call with a longer expiry should be worth more than a call of shorter expiry having the same strike. This check can be represented as follows:

(18)

1. **Butterfly Spread Condition** – A call with a certain strike must be worth less than the average of two adjacent calls of equal distance, this produces a constraint on the convexity of the curve. This check can be represented as follows:

(19)

When an arbitrage exists on the first two conditions, a de-arbitraging process is performed to find the closest volatility surface such that the call spread and calendar spread conditions are met, and where the distance between input volatilities and arbitrage-free volatilities are minimised. Due to the computational complexity in to de-arbitraging butterfly spread arbitrages, the butterfly spread condition will be excluded when de-arbitraging a volatility surface.

# Price Sources

The following market data sources are used in ForexClear in relation to the clearing of FX Spot, Forwards, and Options:

* ForexClear Clearing Members are required to submit price data directly to the service. Price data received includes FX spot rates, forward rates and Smile RRs/FLYs for specified currency pairs and tenors. Price data is submitted by ForexClear Clearing Members every five minutes.
* Interest rate curves are snapped from LCH.Clearnet’s SwapClear service.
* ForexClear takes country credit spreads from Bloomberg for use in Sovereign Risk Margin calculations.

Table 5 summarises all market data sources used in the ForexClear service.

Table 5 - Market data sources

|  |  |  |
| --- | --- | --- |
| Event | Source | Frequency |
| FX spot rates | Members | Every 5 mins (STP) |
| FX forward points  Tenors: S/N, 1W, 1M, 2M, 3M, 6M, 9M, 12M, 24M | Members | Every 5 mins (STP) |
| FX implied volatilities  Deltas: ATM, 25-RR, 25-FLY, 10-RR, 10-FLY  Tenors: O/N, 1W, 2W, 1M, 2M, 3M, 6M, 9M, 1Y, 18M, 2Y | Members | Every 5 mins (STP) |
| Interest rate curves  (USD LIBOR and OIS, EUR EONIA) | SwapClear | Every 30 mins (STP) |
| Country credit spreads (only used in  Sovereign Risk Margin calculations) | Bloomberg | Daily (STP) |

Details of applicable FX spot, FX swap points and Zero Coupon interest rates sourced are contained in Appendix A.

# References

Hull, J. and White, A (1998): “*Incorporating Volatility Updating Into The Historical Simulation Method for Value at Risk”*

Barone-Adesi, G. and Giannopoulos (2000): “*Non-Parametric VaR Techniques – Myths and Realities”*

# Appendix A: Market Data Inputs

The FX spot rates, swap points and interest rate curves that are used as inputs in the *FxPAR* model are shown in the tables below.

**FX Spot Rates**

|  |  |
| --- | --- |
| **Tenor** | **All USD-Currency Pairs** |
| Spot | x |

**FX Forward Rates**

|  |  |
| --- | --- |
| **Tenor** | **All USD-Currency Pairs** |
| O/N | x |
| 1W | x |
| 2W | x |
| 1M | x |
| 2M | x |
| 3M | x |
| 6M | x |
| 9M | x |
| 12M | x |
| 18M | x |
| 24M | x |

**Zero Coupon Interest Rates**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Ternor** | **Days** | **USD  LIBOR** | **USD  FED FUNDS** | **EUR**  **EONIA** |
| O/N | 1 | x | x | x |
| 1W | 7 | x | x | x |
| 2W | 14 | x | x | x |
| 1M | 30 | x | x | x |
| 2M | 60 | x | x | x |
| 3M | 91 | x | x | x |
| 6M | 182 | x | x | x |
| 9M | 273 | x | x | x |
| 1Y | 365 | x | x | x |
| 18M | 547 | x | x | x |
| 2Y | 730 | x | x | x |

**FX Volatilities**

|  |  |
| --- | --- |
| **Tenor** | **All Currency Pairs**  **ATM, 10-RR, 25-RR, 10-FLY, 25-FLY** |
| O/N | x |
| 1W | x |
| 2W | x |
| 1M | x |
| 2M | x |
| 3M | x |
| 6M | x |
| 12M | x |
| 18M | x |
| 24M | x |

1. Not applicable to implied volatility risk factors. [↑](#footnote-ref-1)
2. Refer to document ‘*ForexClear – FXO LRM Methodology v1-0R*’. [↑](#footnote-ref-2)
3. Refer to document ‘ *http://www.lchclearnet.com/documents/731485/762691/Default+Rules.pdf/cfa9379b-e40b-4ac1-aff2-5deca6700858*’. [↑](#footnote-ref-3)
4. Does not apply to implied volatilities. [↑](#footnote-ref-4)
5. See ‘*ForexClear Implied Volatility Smile Interpolation v1.0 (Nov 2015)*’ [↑](#footnote-ref-5)